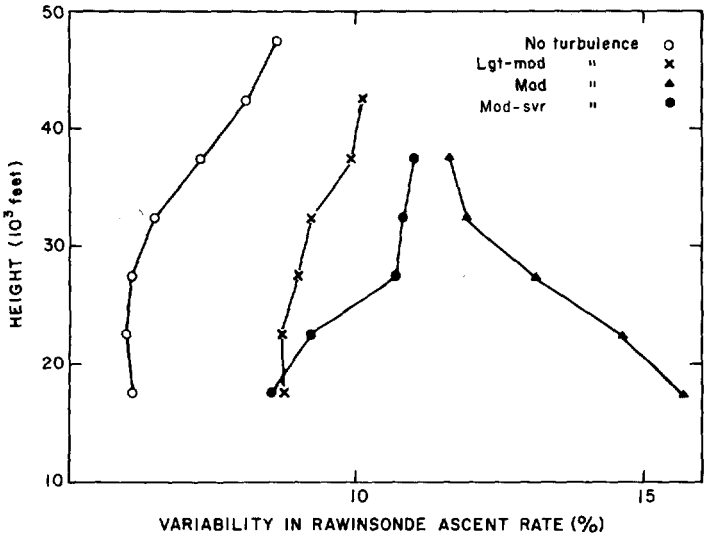

FIGURE 2.—Based on the 12 rawinsonde stations in figure 1, the average variability in rawinsonde ascent rate for cases of "no turbulence" and various categories of turbulence.

Inasmuch as these preliminary results suggest that an in-being observational system may give some clue as to the occurrence of clear air turbulence, I would concur with Dr. Hodge that further studies along this line appear justified. However, these same results suggest that even more useful information could be obtained from a horizontal sounding system. For example, a superpressured, constant-volume balloon with a high drag coefficient would more clearly delineate the vertical air motions involved, and would possess the additional advantage of remaining within the turbulent area for a considerable time. Although there is no doubt that there are difficulties involved in precise radar positioning of such balloons for long time intervals, the constant-volume balloon still seems a logical probe for *research* into the mechanism of clear air turbulence.

REFERENCE

1. Mary W. Hodge, "Large Irregularities of Rawinsonde Ascensional Rates Within 100 Nautical Miles and Three Hours of Reported Clear Air Turbulence," *Monthly Weather Review*, vol. 95, No. 3, Mar. 1967, pp. 99–106.

[*Received April 28, 1967; revised June 14, 1967*]

Reply

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Dr. Angell's letter describes a summarizing technique different from that which I used in table 1 of my paper [1] relating rawinsonde ascensional rate variations to clear air turbulence. I am pleased to have this evaluation and concurring opinion. The ascensional rate computations were those presented in my paper for the 5-day period shown in table 1. The pilot reports furnished Dr. Angell spanned a period ±6 hr. about the times of the rawinsonde observations, while those presented in my paper were ±3 hr. about these times.

Dr. Angell states that "in some cases there is a question as to whether we are dealing with clear air turbulence." If he means that some pilot reports of turbulence may have been associated with high-level clouds exclusive of thunderstorm activity he is correct. I treated all pilot reports of turbulence between about 18,000 and 42,000 ft., excluding those within 100 mi. of known thunderstorm activity. A few reports were near high humidity layers which may have been cirrus clouds. It is not uncommon to include these in the category "clear air turbulence." Also, his term "non-turbulence cases" means simply cases in which there were no pilot reports of turbulence. Absence of pilot reports unfortunately does not define non-turbulent cases.

In my opinion, the results of this study do not suggest that more useful information on occurrences of clear air turbulence in time and position could be obtained from a horizontal sounding system than from the vertical sounding system. In fact I would conclude just the opposite. Because of the thin vertical layer in which turbulence occurs and the variable position in the vertical of such layers it would be difficult to place constant-pressure balloons in turbulent layers. With the assumption that turbulent layers had been previously located by aircraft, one possible technique might be to release constant-pressure balloons in these layers from aircraft [2]. Even then it remains for experiment to prove the value of a horizontal sounding system in the study of clear air turbulence.

I wish again to emphasize the outstanding feature of my study. We have data on real time from the rawinsonde observational system which is not now used. If the continuing study shows these data to be useful in locating clear air turbulence they could be made available to weather and aviation interests with little cost and effort compared to establishing a new observational system.

REFERENCES

1. Mary W. Hodge, "Large Irregularities of Rawinsonde Ascensional Rates Within 100 Nautical Miles and Three Hours of Reported Clear Air Turbulence," *Monthly Weather Review*, vol. 95, No. 3, Mar. 1967, pp. 99–106.
2. D. R. Booker and L. W. Cooper, "Superpressure Balloons for Weather Research," *Journal of Applied Meteorology*, vol. 4, No. 1, Feb. 1965, pp. 122–129.

[*Received May 16, 1967*]